

Prospective VLBI Astrometric Study of FAST

Haiyan Zhang*^{1,2}, Rurong Chen^{1,2}

(1) National Astronomical Observatories of CAS, Beijing, 100101, China, e-mail: hyzhang@nao.cas.cn;

chenrr@nao.cas.cn

(2) CAS Key Laboratory of FAST, National Astronomical Observatories of CAS, Beijing, 100101, China

The 500-meter Aperture Spherical radio Telescope (FAST) has been opened formally for about one year [1]. Many outcomes have been achieved, such as more than 200 new pulsars have been detected. As one of the FAST science goals, Very Long Baseline Interferometry (VLBI) study has been discussed and updated. Due to its unique collecting area, FAST will significantly improve the sensitivity of the current VLBI networks and extend the astronomical researches by observing much weak radio sources.

The science targets for FAST VLBI research have been planned, such as surveying weak compact radio sources to enlarge samples, obtaining the fine structure of Active Galactic Nuclei (AGNs) to study the physical mechanism, implementing high precision astrometric measurement of celestial bodies including pulsars and transient sources with high unprecedented sensitivity [2]. In the next five year, the project to carry out FAST VLBI astrometric measurement of pulsars and Fast Radio Bursts (FRB) has been proposed. By comparing with the results of millisecond pulsar timing observations, the solar system planetary ephemeris and the Milky Way electron density model would be optimized, and the connection precision between the dynamics and kinematics celestial reference frame could be improved. The origin of transient sources represented by the electromagnetic counterparts of gravitational wave and FRB is a hot topic of current astronomy research. This project could achieve the VLBI positioning of several transient sources with high precision, and detect the structure and the evolution of following radiation, which would provide the key information for revealing the burst mechanism of transient sources and the pre-burst environment.

FAST has installed VLBI backend and Mark 6 system, and has the ability to record both pulsar timing and VLBI modes data at the same time. The fringes of the test VLBI observations have been obtained successfully. However, it still needs to be further upgraded to realize the routine operation and observation of VLBI. Several FAST VLBI pulsar observation experiments in 2021 have been scheduled to complete the performance evaluation, optimize settings such as observation frequency and data recording rate, and verify the stability and reliability of VLBI observation equipments. In these experiments, the pulsar located in the sky coverage of FAST with the known inbeam reference source will be selected as the first observation target. Therefore, the VLBI phase-reference measurement of the source could be carried out, which would greatly reduce the system error.

Based on the existed Chinese radio telescopes including FAST, Tianma 65m (TM65), Haoping 40m (HP40) and Nanshan 26m (UR26) radio telescopes, a VLBI network at L band could be established in China, which is about 5 times more sensitive than the Very Long Baseline Array (VLBA) in the United States. In addition, after the completion of Qitai 110m, Jingdong120m and two 40m radio telescopes in Tibet and Northeast China, the most sensitive low-frequency (L-band) VLBI network in the world could be established.

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